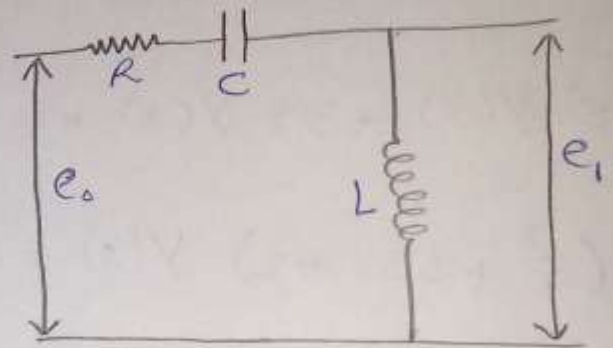
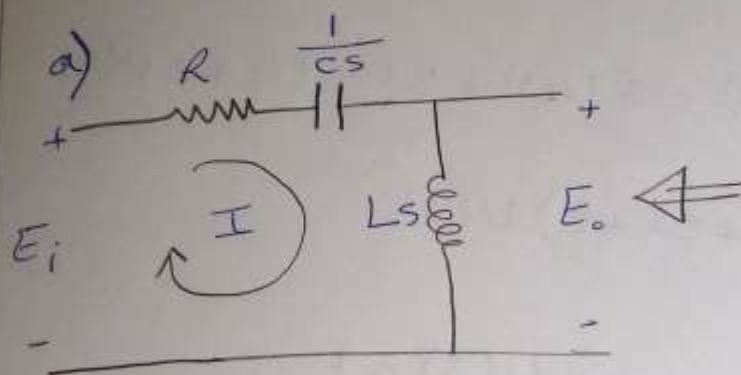


Sheet 2

1) Drive the transfer Function $\frac{E_o}{E_i}$ For the RLC circuits shown in Figure below:-



Sol

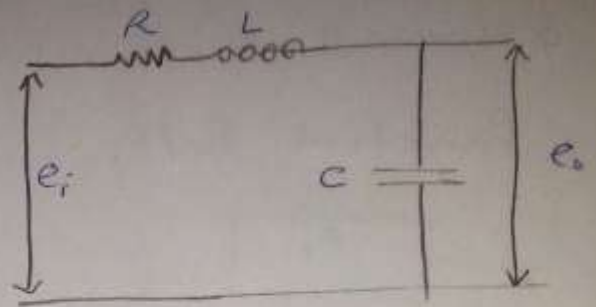
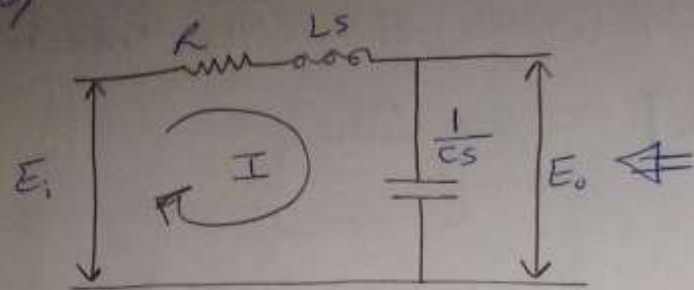
$$E_i(s) = (R + Ls + \frac{1}{Cs}) I \quad \& \quad E_o(s) = I L s$$

$$E_i(s) = (R + Ls + \frac{1}{Cs}) \frac{E_o(s)}{Ls}$$

$$\frac{E_o(s)}{E_i(s)} = \frac{Ls}{R + Ls + \frac{1}{Cs}}$$

$$\frac{E_o(s)}{E_i(s)} = \frac{CLs^2}{1 + RCs + LCs^2}$$

b)

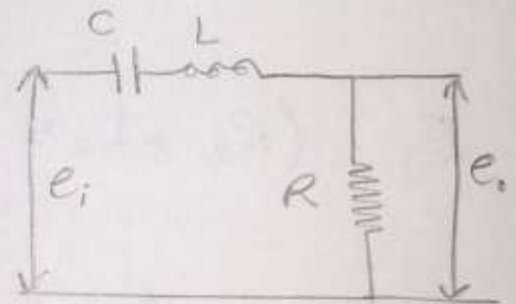
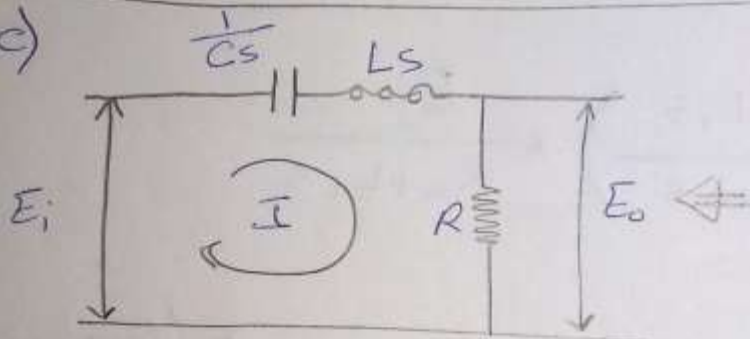


$$E_i(s) = (R + Ls + \frac{1}{Cs}) I \quad ; \quad E_o(s) = \frac{I}{Cs}$$

$$\therefore E_i(s) = (R + Ls + \frac{1}{Cs}) E_o(s) * Cs$$

$$\boxed{\frac{E_o(s)}{E_i(s)} = \frac{1}{RCS + CLS^2 + 1}}$$

c)



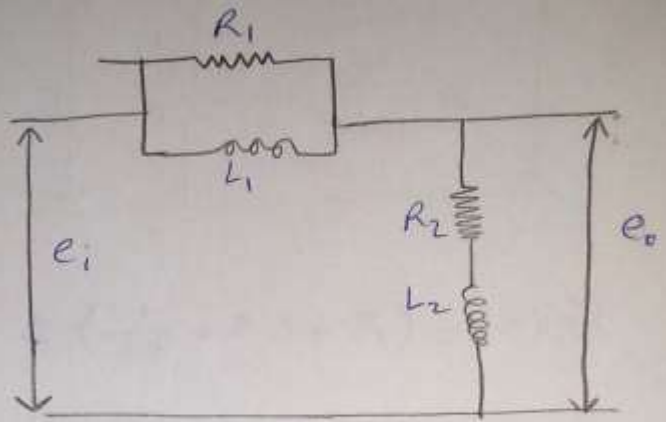
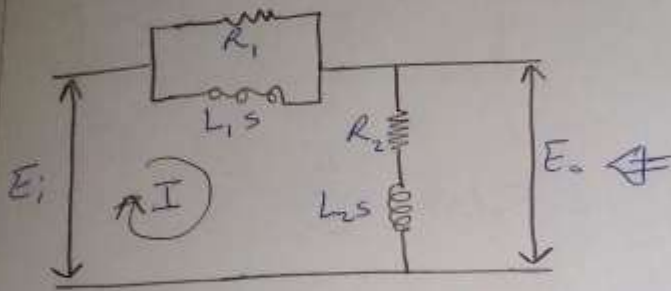
$$E_i(s) = (R + Ls + \frac{1}{Cs}) I \quad ; \quad E_o(s) = IR$$

$$E_i(s) = (R + Ls + \frac{1}{Cs}) * \frac{E_o(s)}{R}$$

$$\frac{E_o(s)}{E_i(s)} = \frac{R}{R + Ls + \frac{1}{Cs}} = \boxed{\frac{RCS}{RCS + Ls^2 + 1}}$$

2] For electrical networks shown in figure below assuming zero initial conditions, obtain the transfer function E_o/E_i .

a]



$$E_i = \left(R_2 + L_2 s + \frac{R_1 L_1 s}{R_1 + L_1 s} \right) I$$

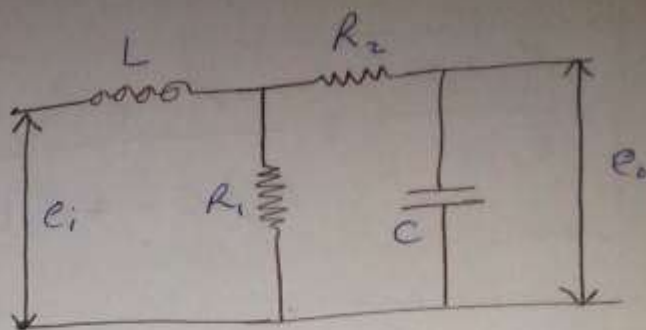
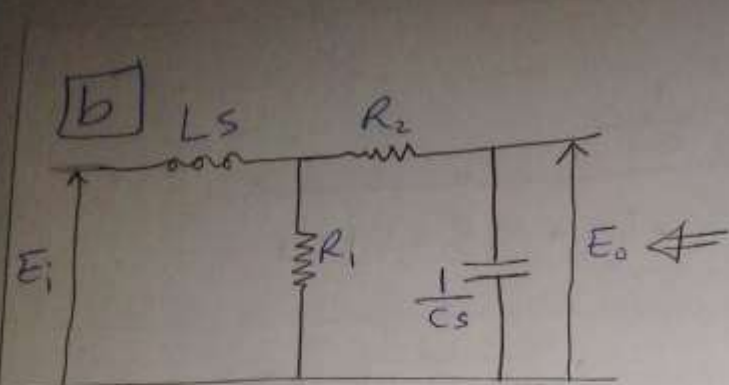
$$E_o = I (R_2 + L_2 s)$$

$$E_i = \left(R_2 + L_2 s + \frac{R_1 L_1 s}{R_1 + L_1 s} \right) \times \frac{E_o}{R_2 + L_2 s}$$

$$\frac{E_o}{E_i} = \frac{R_2 + L_2 s}{R_2 + L_2 s + \frac{R_1 L_1 s}{R_1 + L_1 s}} \times (R_1 + L_1 s)$$

$$\frac{E_o}{E_i} = \frac{(R_1 + L_1 s)(R_2 + L_2 s)}{R_1 R_2 + R_2 L_1 s + R_1 L_2 s + L_1 L_2 s^2 + R_1 L_1 s}$$

3] sheet 2



$$E_i(s) = I L s + V_o \quad ; \quad V_o = I X$$

$$X = R_1 \parallel \left(R_2 + \frac{1}{Cs} \right)$$

$$E_i(s) = \left[L s + \left(R_1 \parallel \left(R_2 + \frac{1}{Cs} \right) \right) \right] * I$$

$$E_o(s) = \frac{I}{Cs}$$

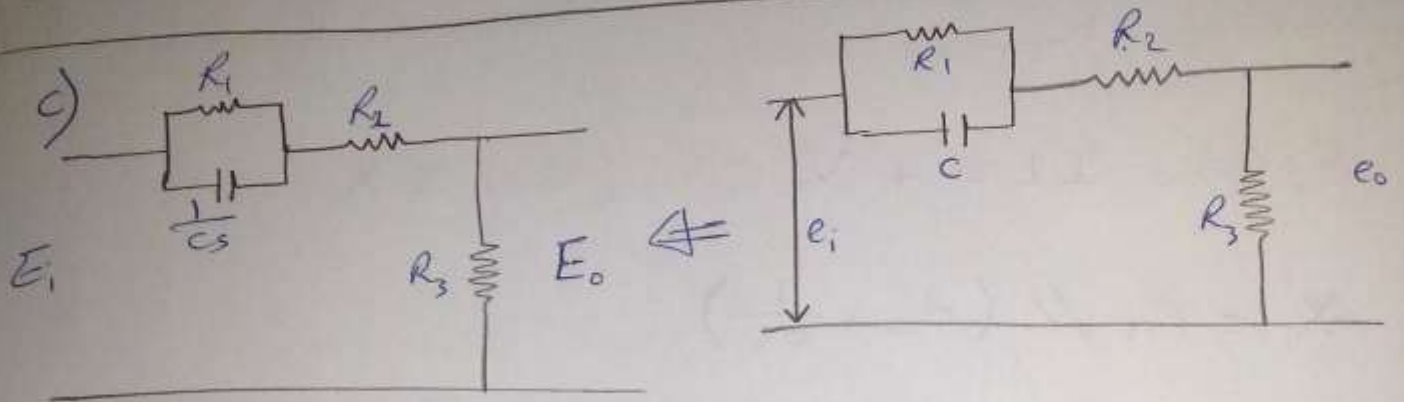
$$E_i(s) = \left[L s + R_1 \parallel \left(R_2 + \frac{1}{Cs} \right) \right] * E_o(s) * Cs$$

$$= \left[L s + \frac{R_1 \left(R_2 + \frac{1}{Cs} \right)}{R_1 + R_2 + \frac{1}{Cs}} \right] * E_o(s) * Cs$$

$$= \left[L C s^2 + \frac{R_1 R_2 C s + R_1}{R_1 + R_2 + \frac{1}{Cs}} \right] E_o(s)$$

$$E_i(s) = \left[\frac{R_1 L C s^2 + R_2 L C s^2 + L s + R_1 R_2 C s + R_1}{R_1 + R_2 + \frac{1}{Cs}} \right] E_o(s)$$

$$\frac{E_o(s)}{E_i(s)} = \frac{R_1 + R_2 + \frac{1}{Cs}}{R_1 L C s^2 + R_2 L C s^2 + L s + R_1 R_2 C s + R_1}$$



$$E_i(s) = \left[R_2 + R_3 + \left(R_1 \parallel \frac{1}{Cs} \right) \right] I$$

$$= \left[R_2 + R_3 + \frac{\frac{R_1}{Cs}}{R_1 + \frac{1}{Cs}} \right] I$$

$$= \left[R_2 + R_3 + \frac{R_1}{1 + R_1 C s} \right] I$$
~~$$= \frac{R_2 + R_1 R_2 C s + R_3 + R_1 R_3 C s + R_1}{1 + R_1 C s} I$$~~

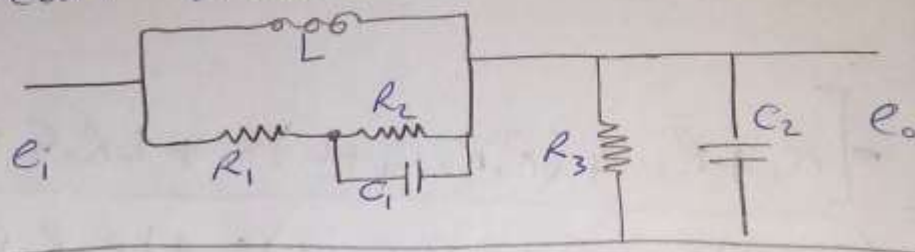
$$= \left[\frac{R_2 + R_1 R_2 C s + R_3 + R_1 R_3 C s + R_1 + R_1^2 C s}{1 + R_1 C s} \right] I$$

$$E_o(s) = I R_3$$

$$\frac{E_o(s)}{E_i(s)} = s \frac{R_3 + R_1 R_3 C_2 s}{R_2 + R_1 R_2 C_2 s + R_3 + R_1 R_3 C_2 s + R_1 + R_1^2 C_2 s}$$

3] using Cramer rule, find the transfer function

$\frac{E_o}{E_i}$ for the circuit given below.



$$E_i = \left(Z + \frac{R_3 \times \frac{1}{C_2 s}}{R_3 + \frac{1}{C_2 s}} \right) I$$

$$\frac{E_i}{I} = Z + \frac{R_3}{1 + R_3 C_2 s}$$

$$Z_1 = \frac{R_2 \frac{1}{C_2 s}}{R_2 + \frac{1}{C_2 s}} + R_1 = \frac{R_2}{1 + R_2 C_2 s} + R_1 = \frac{R_2 + R_1 + R_1 R_2 C_2 s}{1 + R_2 C_2 s}$$

$$Z = Z_1 \parallel Ls = \frac{\frac{R_2 + R_1 + R_1 R_2 C_2 s}{1 + R_2 C_2 s} \times Ls}{\frac{R_2 + R_1 + R_1 R_2 C_2 s}{1 + R_2 C_2 s} + Ls}$$

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$$Z = \frac{(R_1 + R_2)LS + R_1 R_2 L C_1 s^2}{(R_1 + R_2) + R_1 R_2 C_1 s + LS + L R_2 C_1 s^2}$$

$$\frac{E_i}{I} = \frac{L(R_1 + R_2)s + R_1 R_2 L C_1 s^2}{(R_1 + R_2) + R_1 R_2 C_1 s + LS + L R_2 C_1 s^2} + \frac{R_3}{1 + R_3 C_2 s}$$

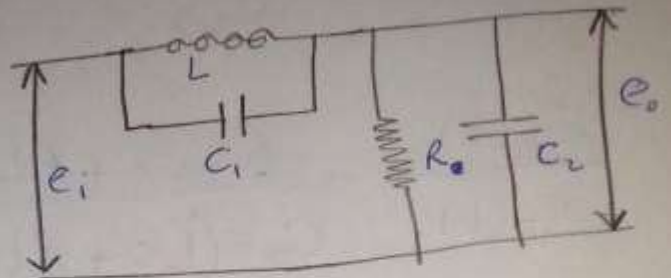
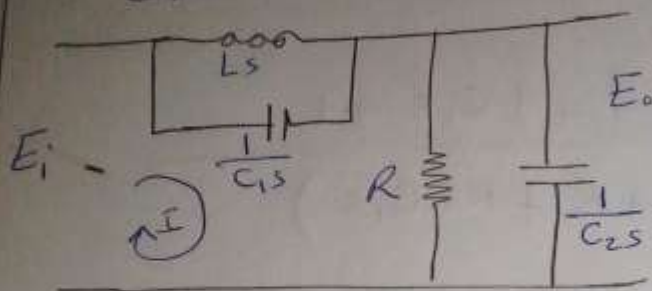
$$\frac{I}{E_i} = \frac{[R_1 + R_2 + (R_1 R_2 C_1 + L)s + L R_2 C_1 s^2](1 + R_3 C_2 s)}{(R_1 + R_2)R_3 + R_3(R_1 R_2 C_1 + L)s + L R_2 R_3 C_1 s^2 + (1 + R_3 C_2 s) \cdot [L(R_1 + R_2)s + R_1 R_2 L C_1 s^2]}$$

→ *

$$\frac{E_o}{I} = \frac{1}{C_2 s}$$

$$\frac{E_o}{E_i} = * \quad * \frac{1}{C_2 s}$$

4] obtain the transfer function E_o/E_i for the circuits shown in figure below.



$$E_i(s) = \left(\left[Ls \parallel \frac{1}{C_1 s} \right] + \left[R \parallel \frac{1}{C_2 s} \right] \right) * I$$

$$= \left[\frac{\frac{L}{C_1}}{Ls + \frac{1}{C_1 s}} + \frac{\frac{R}{C_2 s}}{R + \frac{1}{C_2 s}} \right] * I$$

$$= \left(\frac{Ls}{1 + LC_1 s^2} + \frac{R}{RC_2 s + 1} \right) I$$

$$= \frac{Ls + RLC_2 s^2 + R + RLC_1 s^2}{(1 + LC_1 s^2)(RC_2 s + 1)} * I$$

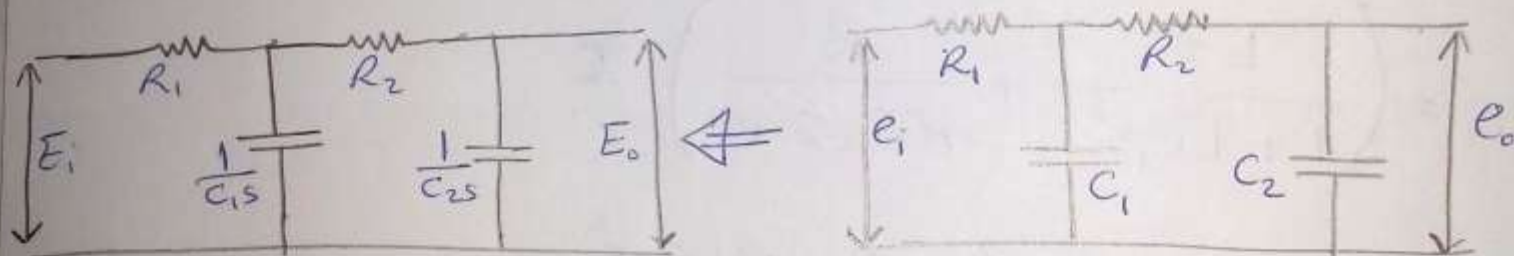
$$E_i(s) = \frac{Ls + RLC_2 s^2 + R + RLC_1 s^2}{RC_2 s + 1 + RLC_1 C_2 s^3 + LC_1 s^2} * I$$

$$E_o(s) = \frac{I}{C_2 s}$$

$$\frac{E_o(s)}{E_i(s)} = \frac{RC_2 s + RLC_1 C_2 s^3 + LC_1 s^2 + 1}{C_2 s (Ls + RLC_2 s^2 + R + RLC_1 s^2)}$$

$$\frac{E_o}{E_i} = \frac{RC_2 s + RLC_1 C_2 s^3 + LC_1 s^2 + 1}{C_2 L s^2 + RLC_2 s^3 + R + RLC_1 C_2 s^3}$$

5] Drive the transfer function E_o/E_i for the RC ladder network given in figure below:-



$$E_i(s) = IR_1 + V_o \quad ; \quad V_o = IX$$

$$X = \frac{1}{C_1 s} \parallel \left(R_2 + \frac{1}{C_2 s} \right)$$

$$= \frac{\frac{1}{C_1 s} \left(R_2 + \frac{1}{C_2 s} \right)}{\frac{1}{C_1 s} + R_2 + \frac{1}{C_2 s}}$$

$$X = \frac{\frac{R_2}{C_1 s} + \frac{1}{C_1 C_2 s^2}}{\frac{1}{C_1 s} + R_2 + \frac{1}{C_2 s}} \quad * C_1 C_2 s^2$$

$$X = \frac{R_2 C_2 s + 1}{C_2 s + R_2 C_1 C_2 s^2 + C_1 s}$$

$$E_i(s) = \left[R_1 + \frac{R_2 C_2 s + 1}{C_2 s + R_2 C_1 C_2 s^2 + C_1 s} \right] * I$$

$$= \left[\frac{R_1 C_2 s + R_1 R_2 C_1 C_2 s^2 + R_1 C_1 s + R_2 C_2 s + 1}{C_2 s + R_2 C_1 C_2 s^2 + C_1 s} \right] * I$$

$$E_o(s) = \frac{I_2}{C_2 s} \quad ; \quad I_2 = I \frac{\frac{1}{C_1 s}}{R_2 + \frac{1}{C_1 s} + \frac{1}{C_2 s}}$$

$$I_2 = \frac{I}{R_2 C_1 s + 1 + \frac{C_1 s}{C_2 s}} = \frac{I C_2 s}{R_2 C_1 C_2 s^2 + C_2 s + C_1 s}$$

$$E_o(s) = \frac{I}{R_2 C_1 C_2 s^2 + C_2 s + C_1 s}$$

$$\frac{E_o(s)}{E_i(s)} = \frac{C_1 s + C_2 s + R_2 C_1 C_2 s^2}{(R_2 C_1 C_2 s^2 + C_2 s + C_1 s)(R_1 C_2 s + R_1 R_2 C_1 C_2 s^2 + R_1 C_1 s + R_2 C_2 s + 1)}$$

$$\frac{E_o(s)}{E_i(s)} = \frac{1}{R_1 C_2 s + R_1 R_2 C_1 C_2 s^2 + R_1 C_1 s + R_2 C_2 s + 1}$$

11 sheet 2